# Chapter 32
# Multimedia Social Network Modeling Using Hypergraphs

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## ABSTRACT

*In this paper the authors define a novel data model for Multimedia Social Networks (MSNs), i.e. networks that combine information on users belonging to one or more social communities together with the multimedia content that is generated and used within the related environments. The proposed model relies on the hypergraph data structure to capture and to represent in a simple way all the different kinds of relationships that are typical of social networks and multimedia sharing systems, and in particular between multimedia contents, among users and multimedia content and among users themselves. Different applications (e.g. influence analysis, multimedia recommendation) can be then built on the top of the introduce data model thanks to the introduction of proper user and multimedia ranking functions. In addition, the authors provide a strategy for hypergraph learning from social data. Some preliminary experiments concerning efficiency and effectiveness of the proposed approach for analysis of Last.fm network are reported and discussed.*

## INTRODUCTION

Nowadays, *Multimedia Sharing Systems* (MSSs) and some *On-line Social Networks* (OSNs) provide users an interactive platform to create and share multimedia content (e.g. text, image, video, audio, etc.) of interest. As an example, each minute thousands of tweets are sent on Twitter, several hundreds

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of hours of videos are uploaded to YouTube, and a huge quantity of photos are shared on Instagram or uploaded to Flickr. In such "interest-based" social networks, each user interacts with the others through the multimedia content of interest and such interactions forming social links that well characterize the behaviors of involved users in the networks.

*Social Network Analysis* (SNA) methodologies have been recently introduced to study the properties of such kind of information networks with the aim of supporting a wide range of applications: information retrieval, influence analysis, recommendation, marketing, event recognition, user profiling, and so on.

In our vision, an additional challenge in the management of social networks derives from the presence of multimedia information and several questions arise, if we consider the important role that multimedia data can assume in a social network:

- Is it possible to exploit multimedia features and notion of *similarity* to discover more links? Are such links effectively useful for analytics purposes?
- Can the different types of user annotations (e.g. tag, comment, review, etc.) and interactions with multimedia objects provide a further support for an advanced network analysis?
- How is it possible to integrate and efficiently manage the information coming from OSNs and multimedia sharing systems (for example, a Facebook user has usually an account also on Instagram or Flickr) in a unique social network? How can we deal with very large volumes of data?
- In this context how is it possible to model all the various relationships among users and multimedia objects? Are the "graph-based" strategies still the most suitable solutions?

The preliminary step to provide an effective answer for the above questions lies in the introduction of a model for *Multimedia Social Networks* (MSNs): integrated networks that combine the information on users belonging to one or more social communities, with all the multimedia contents that can be generated and used within the related environments.

In the literature, the term MSN have been used over the last years together with *Social Multimedia Network* or *Social Media Network* to indicate information networks that leverage multimedia data in a social environment for different purposes: distributed resource allocation for multimedia content sharing in cloud-based systems (Nan, Zang, Dou, & Li, 2015), generation of personalized multimedia information recommendations in response to specific targets of interests (Liu, Ye, Chen, Yan, & Chang, 2012), evaluation of the trust relationship among users (Z. Zhang & Wang, 2013), high dimensional video data distribution in social multimedia applications (Ji et al., 2014), characterization of user behavior and information propagation on the base of multimedia sharing (O'Donovan et al., 2013), representation of a social collaboration network of archeologists for cultural heritage applications (Moscato, Picariello, & Subrahmanian, 2015), just to cite some of the most recent proposals. As we can notice such proposals face only in part the discussed problems, rather focusing their efforts on specific applications.

In this paper we define and implement a novel and general data model for MSNs. Such work represents an extension of a previous one that the authors have presented in a recent conference (Amato, Moscato, Picariello, & Sperlì, 2016). The model allows us to represent in a simple way all the different kinds of relationships that are typical of such environments (among multimedia contents, among users and multimedia content and among users themselves) and to support several kinds of analytics and applications by means of the introduction of some *ranking* functions. In addition, we provide a strategy for hypergraph learning from data coming from different OSNs (e.g. Facebook, Twitter) and MSSs (e.g Flickr, Last.fm, Youtube). Finally, some preliminary experiments concerning efficiency and effective-